U.S. Department of Homeland Security Research & Development Partnerships Group: Product Realization Guide

DHS S&T Portfolio	N/A	Basic Research			Innovation and Transition					
Technology Phase	Needs Assessment	Science			Technology Development			Product Development		
Technology Readiness Level (TRL)	N/A	TRL 1 – TRL 3			TRL 4 – TRL 6			TRL 7 – TRL 9		
Manufacturing Readiness Level (MRL)	N/A	MRL 1 – MRL 3			MRL 4 – MRL 6			MRL 7 – MRL 10		
Key Objectives	❑ Identify S&T needs or capability gaps ❑ Rough draft operational requirements are developed (if appropriate) ❑ Market Survey ❑ Technology Scan ❑ Assess technology-based solutions to address gaps. ❑ Investigate the value proposition ❑ Establish technical objectives and milestones. ❑ Conduct preliminary IP review. ❑ Initiate Congressional Appropriations Memo, Technology Transition Agreements (TTAs), Technology Commercialization Agreements (TCAs), Program Descriptions (Research and Innovation) and Feasibility Studies	**TRL 1** ❑ "Back of the envelope" environment – new approach ❑Research hypothesis formulated ❑ Basic scientific principles observed ❑ Physical laws and assumptions used in new technologies/sciences defined ❑ Have some concept in mind that may be realizable ❑Paper studies support basic principles (literature search) ❑Formulation of concepts that might be realizable (draft road map) – "If – then" statements ❑Has a Feasibility Study White Paper been developed? ❑Has a potential DHS mission space been identified? ❑Identify interest in technology/science, e.g., sponsor, funding source (users/participants: researchers, national/international, private, government, academia, military) ❑Know who will perform research and where it will be done **MRL1** ❑ Basic manufacturing implications identified	**TRL 2** ❑ Basic elements of science/technology identified (math/physics/ chemistry/ analysis/ algorithm) ❑ Components of technology/science partially characterized ❑ Rigorous analytical studies confirm basic principles ❑ Paper studies show that application is feasible ❑ Potential system or component application(s) identified – proof of principle ❑ Individual parts of the technology work ❑ Develop research plan ❑Qualitative idea of risk areas (cost, schedule, performance) ❑ Identify DHS area supported ❑ Requirement tracking system defined-slow requirements creep ❑ Begin market research (Who is interested, outreach, market survey) ❑ Develop a Technology Roadmap. **MRL2** ❑ Manufacturing concepts identified	**TRL 3** ❑ Science known to extent that models and simulations are possible ❑Preliminary system performance characteristics and measures have been identified and estimated ❑ Predictions of elements of technology capability validated by Analytical Studies ❑ Experiments carried out with small representative data sets ❑ Laboratory experiments verify Scientific feasibility ❑ Scaling studies have been started (size, environment, component integrations) ❑ Customer/user identified and participates in requirements definition/ generation. ❑ Risk areas and mitigation strategies identified ❑ Global Research Services search performed ❑ Develop Quality Control Plan standards conformance, reliability ❑ Develop Marketing Plan to include market size and research. **MRL 3** ❑ Manufacturing proof of concept developed ❑ Producibility for key components identified	**TRL 4** ❑ All required technology components integrated for Proof of Concept ❑ Proof of Concept conducted ❑ The customer briefed on the Proof of Concept results ❑Cross-technology uses assessed and identified ❑ FRD finalized ❑ SEMP finalized and updated (TRL 4, 5, & 6) ❑ TEMP completed and updated (TRL 4, 5, & 6) ❑ Configuration Management Plan exists ❑ PMP updated (TRL 4, 5, and 6) ❑ Risk Management Plan updated (TRL 4, 5, and 6) ❑ Program Cost Analysis updated (TRL 4, 5, and 6) ❑ Quality Assurance Plan exists ❑ Begin transition planning. **MRL 4** ❑ Materials, machines and tooling have been demonstrated in a laboratory environment ❑ Producibility assessments initiated	**TRL 5** ❑ ORD and CONOPS developed ❑ Security Assessment updated ❑ OMB 300 and Acquisition Plan completed (if required) ❑ IPT certified readiness for the transition of the Technology ❑ Program Transition Manager assisted in transition documentation development ❑ Technology scan and market survey (ongoing) ❑ Analysis of Alternatives developed and updated (TRL 5 & 6) ❑ Entry Criteria Checklist completed and delivered to the TM ❑ PDD created, approved, and signed (TRL 5 & 6) ❑ Director approved the transition **MRL 5** ❑Manufacturing cost/goals identified. Potential materials sources identified. ❑ Capability to produce prototype components in product relevant environment	**TRL 6** ❑ Execute TTA / TCA as applicable ❑ Program Manager identified. ❑ Successful T&E in a simulated operational environment conducted. ❑ End user / customer briefed on the results of T&E. ❑ Initial Security Guidelines developed ❑ Draft Program Assessment Rating Tool (PART) plan exists, if required ❑National Environmental Policy Act (NEPA) plan / assessment ❑ Interoperability Assessment **MRL 6** ❑Capability to produce system prototype in product relevant environment. ❑ Production cost drivers and goals analyzed and set **Specific to Commercialization** ❑ Finalize Manufacturing Plan. ❑ Finalize engineering documentation. ❑ Update Marketing Plan. ❑ Develop and implement a test plan for quality control.	**TRL 7** ❑ S&T and the end-user / customer develop final transition plan; (TRL 7 and 8) ❑ Technology successfully demonstrated in an operational environment. (TRL 7 and 8) ❑ Updates made to the ORD. ❑ Risk Management Plan, Program Cost Analysis and PMP updated. ❑Strategic Program Planning conducted. ❑ Operations and Maintenance Manual completed / updated. ❑ Security Manual developed. ❑ Interoperability demonstrated. ❑ MDs reviewed for compliance. **MRL 7** ❑Production pilot begins ❑ Producibility of system in production representative environment **Specific to Commercialization** ❑ IP Protection and Licensing. ❑ Prepare sales release package. ❑ Verify and update quality control requirements.	**TRL 8** ❑ Technology components are form, fit, and function compatible with an operational system. ❑ Technology production addressed and planned by DHS and the end-user / customer. ❑ Training Plan developed and implemented. (TRL 8 and 9) ❑ Operational Test Report completed. ❑ Limited User Test (LUT) Plan developed. ❑ Physical and functional interfaces clearly defined **MRL 8** ❑ Manufacturing pilot complete, ready for low-rate production	**TRL 9** ❑ All critical program documentation completed. ❑ Planning underway for the integration of the next generation technology into the existing program components. ❑ End-user fully demonstrates the technology in CONOPS. ❑ Lessons Learned completed. ❑ After Action Review completed. ❑ Sustainment Plan is completed. **MRL 9/10** ❑Manufacturing processes established and deliver quality products ❑ MRL 10 – System is at full production rate. Products meet all engineering, performance, quality and reliability requirements. **Specific to Commercialization** ❑ Finalize quality plan. ❑ Finalize marketing plan. ❑ Finalize manufacturing and assembly routines.
Key Deliverables	❑ Preliminary market assessment and technology scan. ❑ Congressional Appropriations Memo, Technology Transition Agreements, Program Descriptions (Research and Innovation), and Feasibility Studies lead to Program and Budget Execution.	❑Feasibility Study (White Paper) ❑Initial scientific observations reported in journals/conference proceedings/technical reports ❑Literature search report ❑Road Map (draft) ❑ Written report of findings and recommendations (preliminary product plan). ❑ Feasibility Review meeting.	❑Program Cost Analysis ❑Study showing application is feasible ❑Modeling & Simulation Report used to verify physical principles ❑Market survey identifying potential customer interest ❑Analytical studies reported in scientific journals/conference proceeding/technical reports ❑Qualitative idea of risk areas (cost, schedule, performance, impacts of idea) ❑5 year Investment Strategy/Funding requirements documented ❑ Preliminary product plans (approved and ongoing). ❑ New Technology roadmaps (approved for further development and implementation). ❑ Updated market assessment and technology scan. ❑ Demonstrate ability to manufacture prototype components	❑Technology Maturity Assessment ❑Program Cost Analysis (updated) ❑Functional Requirements (draft) ❑Proof of Concept ❑Program Management Plan (PMP) draft ❑User/Customer Status Review ❑Analytical study/test reports. ❑ Detailed product and marketing plan. ❑ Quality control plan. ❑ Optimization Review meeting. ❑ Manufacturing concepts defined	❑ Proof of Concept Report. ❑ Functional Requirements Document. ❑ SEMP (TRL 4, 5, and 6) ❑ TEMP (TRL 4, 5, and 6) ❑ Quality Assurance Plan. ❑ Configuration Plan Management. ❑ PMP (updated). (TRL 4, 5, & 6) ❑ Risk Management Plan (updated). (TRL 4, 5, and 6) ❑ Program Cost Analysis (updated). (TRL 4, 5, and 6) ❑ End-user / Customer Status Review.	❑ ORD and CONOPS. ❑ Security Assessment (updated). ❑ Program Definition Document (PDD). ❑ OMB 300 Capital Asset Plan. ❑ Acquisition Plan. ❑ Entry Criteria Checklist. ❑ Analysis of Alternatives. (TRL 5 and 6) ❑ Initial producibility of component technology completed ❑ Initial Manufacturing Plan developed.	❑Technology Transition Agreement (TTA), or Technology Commercialization Agreement (TCA) as applicable ❑ Initial Security Guidelines. ❑ Draft Program Assessment Rating Tool (PART) plan, if required. ❑ National Environmental Policy Act (NEPA) initial assessment, if required. ❑ Interoperability Assessment. **Specific to Commercialization** ❑ Engineering documentation release ❑ Updated marketing plan. ❑ Test plan for quality control. ❑ Development Phase Review meeting.	❑Transition Plan (draft). ❑ ORD / FRD Documentation ❑ Risk Management Plan ❑Program Cost Analysis ❑PMP (updated). ❑ Strategic Program Planning Documentation (if conducted). ❑ Operations/Maintenance Manual ❑ Security Manual. ❑ Finalized Interoperability Assurance Report. (TRL 7 and 8) **Specific to Commercialization** ❑ IP Protection and Licensing. ❑ Manufacturing and sales plan release package is to be distributed. ❑ Pilot Phase Review meeting	❑Limited User Test (LUT) Plan. ❑ Deployment or Transition Plan. ❑ Training Plan. ❑ Operational Test Report. ❑ Customer Acceptance Document. ❑ Initial Systems-level Metrics Assessment. **Specific to Commercialization** ❑ Demonstrate that a defect-free product can be produced on schedule and at a cost within the target price points.	❑Customer Feedback. ❑ Lessons-learned. ❑ After-action Review. ❑ Sustainment Plan is completed (a. Spiral Development Assessment, b. Preplanned Product Improvement, c. Emerging Threat(s) Assessment, d. Technology Refresh / Insertion, e. Quality Assurance / Metrics Report, f. Risk Management Reassessment) **Specific to Commercialization** ❑ Finalized product plan sales release package is to be distributed. ❑ Sales Release Phase Review mtng. ❑ Execution of acceptance, shipment, and after-sales support of the product.
RDP Partnership Opportunities and Vehicles	Special Projects Office Interagency Office National Labs and S&T Labs Research and Development Long Range Broad Agency Announcement University Program Grants and Research Development SBIR Phase I ICPO International Research Grants ICPO International Agreements FutureTECH Program (TRL 1-6) Technology Transfer Office SBIR Phase II SBIR Phase III SECURE Program (TRL 5-9) SAFETY Act Developmental T&E:TRL 6-7 Designation: TRL 7-9 & Certification: TRL9									

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Legend:
Black Type – Primary Public Sector
Blue Type – Primary Private Sector
Red Type – Manufacturing related activities
Definition of acronyms on reverse page.

Product Realization Guide

- This guide is designed as a resource to assist in project execution relative to technology development. This systematic approach facilitates efficient and effective product development by reducing the risk of unidentified errors and product development shortfalls. It is intended that this guide be incorporated as an easy-to-use resource to ensure due diligence throughout the product development life cycle. Please note that this guide presents a general framework for product realization and that individual projects may require a tailored product realization path.

- Additional information on TRLs, MRLs and other product development related resources can be found at the following links:
  - Technology Readiness Assessment (TRA) Deskbook, July 2009 - https://acc.dau.mil/CommunityBrowser.aspx?id=18545
  - Definition of Technology Readiness Levels - http://esto.nasa.gov/files/TRL_definitions.pdf
  - Technology Readiness Levels NASA white paper, April 1995 - http://www.hq.nasa.gov/office/codeq/trl/trl.pdf
  - Using the Technology Readiness Levels Scale to Support Technology Management in the DoD's ATD/STO Environments, September 2002 - http://www.sei.cmu.edu/reports/02sr027.pdf
  - DHS S&T Technology Readiness Level Calculator (ver 1.1.) - http://www.homelandsecurity.org/hsireports/DHS_ST_RL_Calculator_report20091020.pdf
  - DAU TRL Calculator - https://acc.dau.mil/CommunityBrowser.aspx?id=25811
  - Manufacturing Readiness Assessment (MRA) Deskbook, May 2009 - https://acc.dau.mil/CommunityBrowser.aspx?id=182129
  - Assessing Manufacturing Risk - https://acc.dau.mil/CommunityBrowser.aspx?id=18231
  - GAO Report – Defense Acquisitions: Assessment of Selected Major Weapons Programs - http://www.gao.gov/new.items/d06391.pdf
  - About Manufacturing Readiness Assessments - http://www.wpafb.af.mil/library/factsheets/factsheet.asp?id=9757

- For more information about the Research & Development Partnerships Group please visit: http://www.dhs.gov/xabout/structure/editorial_0530.shtm or send an e-mail to SandT_RDPartnerships@dhs.gov.

List of Acronyms:
TRL – Technology Readiness Level
MRL – Manufacturing Readiness Level
FRD – Functional Requirements Document
ORD – Operational Requirements Document
SEMP – Systems Engineering Master Plan
TEMP – Test & Evaluation Master Plan
PMP – Program Management Plan
CONOPS – Concept of Operations
PDD – Program Definition Document
PART – Program Assessment Rafting Tool
TTA – Technology Transition Agreement
TCA – Technology Commercialization Agreement
NEPA – National Environmental Policy Act
MD – Management Directive
LUT – Limited User Test